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Sea level rise versus dredging strategies; which one has more impact on estuarine morphodynamics?

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Abstract

Channel-shoal patterns evolve in estuaries due to the interaction between tidal forcing, waves associated sediment transport and morphodynamic developments. While shoals comprise unique ecosystem values, the main channels are often used as access channels to ports connecting ocean transport to inland shipping and other transport mechanisms to the hinterland. The access channels often need to be sustained by regular dredging and disposal activities. Anticipated sea level rise scenarios will impact the morphodynamic evolution of estuaries. It is questioned whether the estuarine morphology can keep up with sea level rise. Tidal asymmetry and tide residual sediment transport may change due to possible deepening of channels and drowning of intertidal flats.

This study aims to investigate the relative importance of sea level rise and different dredging strategies on the morphodynamic behavior of the Western Scheldt Estuary in the Netherlands. We apply a process-based model (Delft3D) to assess potential intervention measures. Our methodology describes 100 year morphodynamic runs that we subject to different sea level rise scenarios (rates and linear vs exponential) and dredging strategies that maintain a prescribed bed level with respect to a rising mean sea level under different disposal strategies.

Model results show that the estuary slowly deepens since morphodynamic adaptation lags behind sea level rise. SLR increases the sediment export from the estuary. More landward sections maintain their import trend albeit at a decreased rate. Despite the clear signal by sea level rise, applied dredging strategies seem to have the major impact on sediment redistribution within the estuary. Disposing dredged sediments in deeper parts of the channel leads to less sediment export from the system than disposing the sediments on shoals. However, the former disposal strategy leads to a more pronounced drop in intertidal area.

Keywords

Estuarine morphodynamics, Sea level rise, Dredging strategies, Intertidal area